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PUMÉ EXPLOITATION OF *MAURITIA FLEXUOSA* (PALMAE) IN THE LLANOS OF VENEZUELA

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ABSTRACT.—The benefits and potential cumulative effect of Pumé exploitation of *Mauritia flexuosa* L.f. (Palmae) are covered. The Pumé (also called Yaruro) live in semi-nomadic villages in the Venezuelan Llanos where they depend on fishing, hunting, gathering of wild foods, and some gardening of manioc and corn. *M. flexuosa* is a palm species characteristic of low-lying flooded areas throughout South America and is used by the Pumé for food, fiber, and building materials, but the most important use is for thatching houses. The various houses maintained by a single Pumé community contain some 13,498 fronds which means an annualized harvest of approximately 577 mature palms. Upon disposal, this quantity of fronds provides an estimated 3,373 kg of dry matter to the soil of the settlements involved.

RESUMEN.—Se describen los beneficios y efectos cumulativos potenciales de la explotación de *Mauritia flexuosa* L.f. (Palmae) por parte de los Pumé. Los Pumé (también llamados Yaruro) viven en aldeas semi-nomádicas en los Llanos de Venezuela, donde dependen de la pesca, caza, recolección de alimentos silvestres, y algo de cultivo de yuca (mandioca) y maíz. La *M. flexuosa* es una especie de palma decaracterística de lugares bajos e inundados distribuida ampliamente en América del Sur, y los Pumé la utilizan como alimento, fibra y material de construcción, pero el uso más importante es para techar casas. Las varias viviendas mantenidas por una comunidad Pumé contienen alrededor de 13,498 pencas de palma, lo cual significa una cosecha anual de aproximadamente 577 palmeras maduras. Al ser desechadas, esta cantidad de hojas contribuyen al suelo una masa estimada de 3,373 kg de materia seca en las comunidades donde son empleadas.

RÉSUMÉ.—Cet article décrit les avantages et les effets cumulatifs possibles résultant de l'exploitation de *Mauritia flexuosa* L.f. (Palmae) par les Pumé. Les Pumé (également connu sous le nom de Yaruro) habitent des villages semi-nomadiques dans les llanos du Venezuela où ils vivent de pêche, de chasse, de cueillette et, dans une moindre mesure, de culture du manioc et du maïs. *M. flexuosa* est une espèce de palmier caractéristique de régions basses et inondées de l'Amérique du Sud qui est utilisée comme nourriture, fibre et matériau de construction, en particulier pour les toits des habitations. Les diverses maisons d'une seule communauté pumé nécessitent l'emploi d'environ 13,498 frondes, ce qui représente une récolte annuelle approximative de 577 palmiers mûrs. Après usage sur les toits, la même quantité de frondes enrichit le sol des communautés concernés d'environ 3,373 kg en matière sèche.

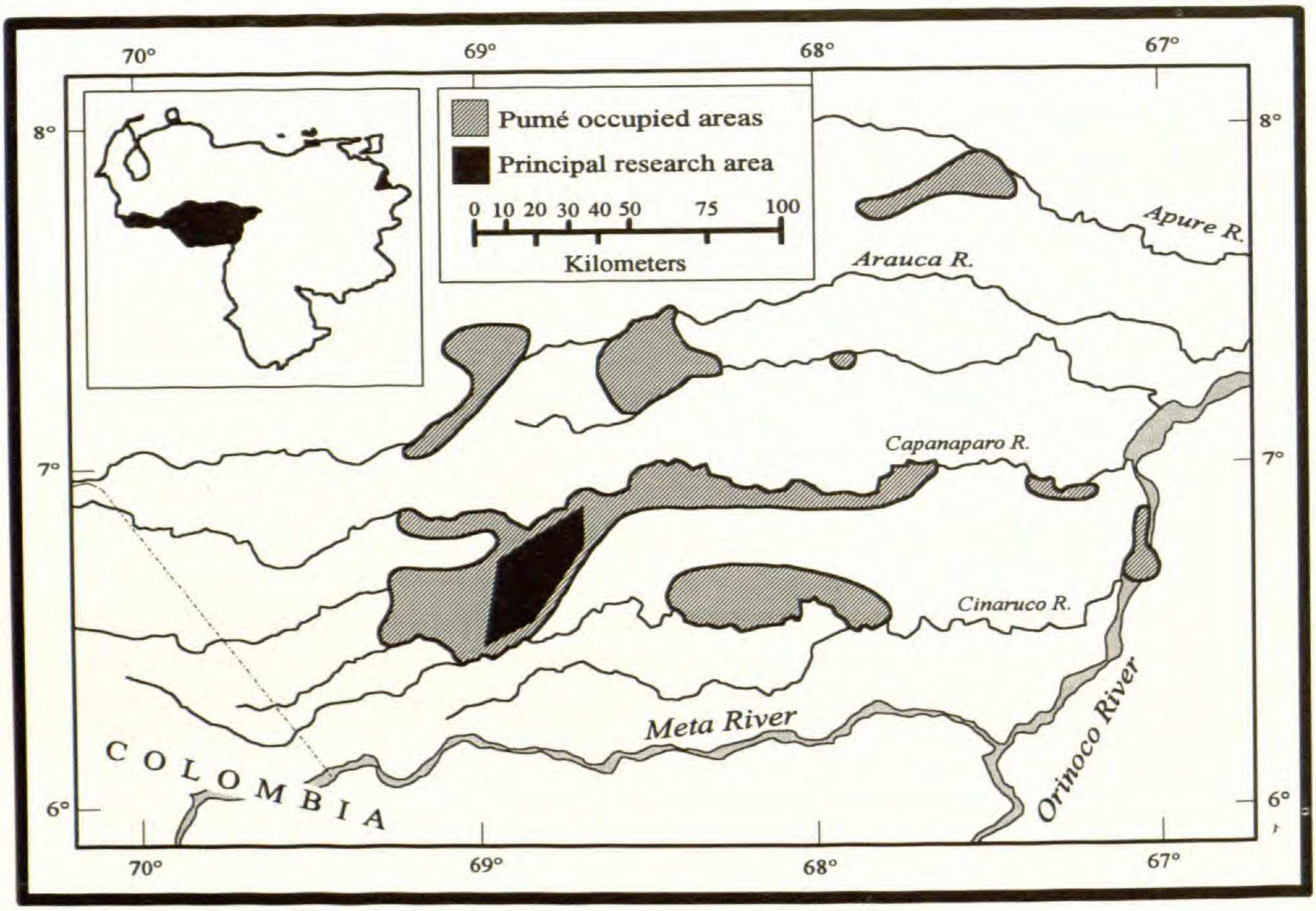

FIG. 1.—Location of the Llanos de Apure in Venezuela and distribution of Pumé villages thoughout the area (based on Lizarralde in Mitrani 1988).

INTRODUCTION

Few palm species have ever been domesticated worldwide yet they probably provide more economic benefits to humans in the form of food, fiber, building materials, fuelwood, and folk medicine than any other family of plants (Uhl and Dransfield 1988; Johnson 1988; Beckerman 1979; Lévi-Strauss 1950; Balick 1986; Clement 1988). Despite the many benefits derived from palms very little is known about the environmental effects of exploiting palms. This is a relevant issue because it has been shown that native peoples in South America can decidedly modify through low-intensity disturbance the productivity and structure of portions of the environment they inhabit (Stocks 1983; Posey 1983, 1984; Balée 1988; Anderson and Posey 1989; Bodley and Benson 1979). For example, to thatch a traditional communal Barí house *(bohio)* may require as many as 750,000 palm leaves (*Geonoma* spp. [Palmae]) leaves harvested from approximately 125,000 plants over a 40 km^2 area (Beckerman 1977). The environmental effects of Barí housebuilding are unknown, but the evidence is supportive of Balée's (1988) argument about indigenous adaptation to Amazonian palm forests.

BACKGROUND

The Pumé (also called Yaruro in the earlier literature) inhabit the Llanos de Apure of southwestern Venezuela located west of the Orinoco river and south of the Apure river (Figure 1). The Llanos de Apure with an average elevation of less than

TABLE 1.—Use of *Mauritia flexuosa* by the Pumé.

Anatomical part	Major time of harvest	Principal use
heart	March–May	food
fruit	June–August	food
stem	March–May	food (larva)
leaf	March–May	house thatch, baskets, manioc sifters
sword leaf	November–May	cordage and fiber, hammocks, baskets and bags, manioc press, floor mats, loin cloth, mosquito net[1]
petiole	as needed	rafts, shelving, barriers and fences

[1]During historic times before cloth became widely available.

200 m above m.s.l. lie at the center of a tropical savanna extending from the Delta of the Orinoco in northeastern Venezuela to the Guaviare river in southern Colombia. The average annual rainfall in the area occupied by the Pumé is nearly 2,000 mm, but most precipitation is concentrated in a 5 month rainy season (May-September). The seasonal concentration of rainfall combined with the slight gradient of the Llanos de Apure results in extensive flooding that can last from 1 to 10 months out of the year (Zink 1986; Andel and Postma 1954; FAO 1965; Goosen 1964).

In 1986–1987 and again in 1989 I conducted ethnographic research on the subsistence ecology and settlement practices of ***čiri k^{h}onome*** Pumé who represent the least acculturated segment of Pumé society (Gragson 1989, 1992a). The ***čiri k^{h}onome*** Pumé constitute approximately 17% of the total Pumé population in Venezuela of 3,873 (OCEI 1985) and occupy the interfluvial savanna between the Capanaparo and Cinaruco rivers. The ***bea k^{h}onome*** Pumé represent the balance of the population and live on the margins of the principal rivers traversing the Llanos. The ***čiri k^{h}onome*** Pumé live in semi-nomadic villages following a subsistence pattern based on fishing, hunting, gathering of wild foods, and some gardening of manioc and corn (Gragson 1992a). Like most other native South Americans, the ***čiri k^{h}onome*** Pumé rely extensively on palms for fiber to manufacture artifacts and clothing, food in the form of fruits, palm heart, and larvae, and leaves used to thatch houses and make additional artifacts (Gragson 1992b).[1]

MAURITIA FLEXUOSA AS A RESOURCE

Mauritia flexuosa L.f. (Palmae) is a solitary, arborescent palm growing to a height of 30 m with reduplicate and palmate leaves with a short midrib. The stem is unarmed, grayish-brown in color, and bears distinctive leaf scars. *M. flexuosa* is the most widely used of all palms among the Pumé (Table 1). (The other palms used are *Astrocaryum jauari* Mart., *Euterpe precatoria* Mart., and *Mauritiella aculeata* (Kunth) Burret [Gragson 1992b].) The cuticle separated from the leaf segment of the young, unrolled leaf (sword leaf) is sun-dried and used as a multipurpose fiber. Dyed red by boiling in a decoction of *Arrabidaea chica* (H. et B.) Verl. (Bignoniaceae) leaves, the fiber is used as a "loincloth" by women. The fiber can be woven to make small bags for holding personal possessions, slings for carrying babies, and most importantly mats; soils in this area are loose and sandy, and mats are used for sitting on, laying uncooked and prepared food on, and as wind or rain shields. Twined, the fiber is used to manufacture the hammocks Pumé sleep in.

A byproduct of fiber extraction are the prominent midribs found on each leaf segment, which are loosely woven into manioc flour sifters. Whole, mature leaves of *M. flexuosa* are used to weave floor mats, upright windshields, and the large baskets used to store personal belongings and to carry manioc, wild roots and firewood. The major use of mature leaves, however, is for thatching houses. After sun-drying for several days, leaves are split in half lengthwise and hung over roof slats typically made from the stem of *Mauritiella aculeata* (Palmae).

Dry petioles of acaulescent juveniles of *M. flexuosa* reach lengths of 5 m and are fairly straight, quite rigid, and extremely light. The petioles of acaulescent juveniles are used to make fences around small patches of squash or tobacco within the village. Several petioles can also be pierced onto a stick to form a platform used as a shelf when suspended from the rafters of Pumé houses, a windbreak/rainshield when stuck upright into the ground or as a personal water raft. Petioles are charred and the ash mixed with resin droplets of *Symphonia globulifera* L.f. (Guttiferae) to manufacture a substance used to seal, bind, and waterproof a multitude of manufactured items. *M. flexuosa* items consumed include the fruit, the palm heart and the large *Rhynchophorus palmarum* L. (Bruchidae) larvae which inhabit rotten stems of this species.

MAURITIA FLEXUOSA AS AN ECOSYSTEM UNIT

M. flexuosa is undoubtedly the most widely used species of palm by Native and non-native alike in South America (Ruddle *et al.* 1978; Anderson 1978; Clastres 1972; Balick 1985; van den Berg 1984). It is also the most widely distributed species of palm in Amazonia (Uhl and Dransfield 1988; Kahn 1988; Balick 1984; Ruddle *et al.* 1978) a fact already noted by Spruce during his travels throughout South America over 100 years ago (1869:77): "The most universally distributed palm throughout the basins of the Amazon and Orinoco, or, say from the Andes of Peru and New Granada [Colombia] to the shores of the Atlantic, is undoubtedly *Mauritia flexuosa* (L.)." The distribution of *M. flexuosa* outside the Amazon basin has been postulated as due to human transportation (Kahn and de Granville 1992).

M. flexuosa is characteristic of seasonally flooded swamp-forests such as várzea, igapó, and gallery located adjacent to rivers and streams but achieves its highest density in permanently flooded swamps (Table 2). Soils in these areas tend to be hydromorphic (e.g., gleysol, district histosol), highly acidic (down to pH 3.5), and can have several meters accumulation of slightly decomposed organic matter (Kahn 1988, Aristeguieta 1968, Braun 1968, Moore 1973, Pires and Prance 1985, Kahn and de Granville 1992). *M. flexuosa* occupies poorly drained soils characterized by anaerobic conditions through reliance on aerial roots with pneumatophores similar to other swamp-dwelling palms of America and Africa—e.g., *Raphia* spp. (de Granville 1974, Profizi 1985, Kahn and de Granville 1992).

M. flexuosa is frequently a dominant among the palm species found in swampy environments, this observation is recognized in popular and scientific classifications

TABLE 2.—Systematics and ecology of *Mauritia flexuosa* L. f. (Palmae).

Scientific name:	*Mauritia flexuosa* Linnaeus filius	
Common names:	Bolivia:	*palma real;*
	Brazil:	*caraná, buritî, muriti, muriti do brejo, ita;*
	Colombia:	*aguaje, canangucha, moriche;*
	Ecuador:	*acho, aguaschi, morete;*
	French Guiana:	*palmier bâche;*
	Guyana:	*aeta, aete, eta, ita, ite palm;*
	Peru:	*achuál, aguaje;*
	Surinam:	*maurisie, morisi;*
	Venezuela:	*moriche.*

Biogeography: solitary tree-palm distributed between approx. 14 S Lat and 14 N Lat throughout the island of Trinidad and South America east of the Andes (Bolivia, Brazil, Colombia, Ecuador, Fr. Guiana, Guyana, Peru, Surinam, and Venezuela); found at elevations below 500 m, typically growing on swampy or seasonally flooded lands with poor drainage and acid soil; often forms dense, almost pure stands with up to 645 indiv/ha.

Root: subterranean root branches into small, thin, absorbing roots; aerial roots have pneumatophores for oxygen uptake; can also produce many 2–10 cm long erect aerial rootlets on stem ("aerial root muff").

Stem: 15–30 m tall typically 0.3–0.6 m in diam. but reported up to 1.75 m; cortex is hard, unarmed and straight with distinct internodes; middle of stem is sometimes swollen; pith is spongy, reddish in color and contains up to 60% dry weight in starch (up to 60 kg starch can be extracted); sap can be fermented to produce a wine; rotten stems (particularly male plants) inhabited by the edible *Rhyncophorus sp.* (Bruchidae) larva (up to 500 larvae/stem).

Leaf: 10–12 per palm and restricted to a terminal crown; production 5–12 leaves/palm/year; briefly costapalmate, approx. 3.0 m in diam. with deeply cut and glossy green blades 0.8–1.2 m long and 1.5–2.0 m wide; leaf-blades bear a low hastula-like crest (^shaped) adaxially at base and have prominent midribs; leaf-blades are 2–4 cm wide drooping at tips; last 2–3 years as thatch. Petioles 2–3 m long and conspicuously adaxially channeled near base; otherwise circular in cross-section, smooth and unarmed.

Flower: dioecious, but occasionally hermaphroditic; interfoliar (originates among leaves), persistent and pendulous; 2–3 m long with numerous short, tubular bracts, and catkin-like branches; male flower has six stamens; young inflorescence produces a sap that can be fermented into wine.

Pollination: known pollen transporter is *Melipona seminigra merrillae* (Apidae).

Fruit: 5–8 fruiting panicles per tree with up to 724 fruits per panicle; productivity 6.1–9.1 mt fruit/ha/yr. Fruit is large, usually one-seeded and sometimes wider than long: 4 cm in diam. and up to 5 cm long with depression at top; loricate pericarp: many neat vertical rows of reflexed scales, red-brown when mature; rather thick, fleshy, edible, yellowish-red mesocarp; spongy, undifferentiated endocarp; corneous, homogeneous endosperm. Average fruit weight 75 g; mesocarp represents 20.5% and endocarp 12.0% of fresh weight; moisture constitutes 67%. Mesocarp contains up to 12.0% oil, woody seed and kernel up to 4.8% oil, dry remainder of meso- and endocarp; 5.2% protein, 26.2% fat, 38.2% starch and sugar, 2.9% ash, 27.5% cellulose, 30–300 mg/100 g edible portion b-carotene (50,000–500,000 IU provitamin A), and 18.4 mg/100 g edible portion a-tocopherol (vitamin E). Seeds are used as vegetable ivory; nuts are baked, ground and consumed as abortifacent.

TABLE 2.—Systematics and ecology of *Mauritia flexuosa* L. f. (Palmae). (continued)

Phenology: flowering: annually for a period of approximately 2 months during the dry season. Fruiting: annually for a period of up to 6 months during the wet season. (Wet and dry season months vary north and south of the equator.)
Seed dispersal: probably by water as a result of spongy endocarp. Seed known to pass intact through the gut of *Tapirus terrestris* (Tapiridae), which defecates in water.
Germination: embryo sprouts laterally from fresh seeds in 65 days and from stale seeds in 210–270 days; thrives in partial shade as well as full sun; requires hot climate and swampy, strongly acid soil (≈3.5 pH).
Sources: Absy and Kerr (1977), Balick (1979, 1984, 1985), Balick and Beck (1990), Beckerman (1979), Bodmer (1991), Braun (1968), Cavalcante (1976), Dahlgren (1936), de Granville (1974), Kahn (1988), Kahn and de Granville (1992), Kubitzki (1985), Marx and Maia (1983), McCurrach (1960), Pesce (1944), Peters (personal communication, 1987), Pires and Prance (1985), Ruddle et al. (1978), Spruce (1869), Tomlinson (1961), Uhl and Dransfield (1987), Wilbert (1976).

tions as a distinct formation called a *morichal*, a *buritizal*, or an *aguajal* (Moore 1973, Blydenstein 1967, Pires and Prance 1985, Beard 1944). In forested areas of the Amazon basin, the absolute density of *M. flexuosa* ranges from 15 to 645 individuals/ha and its relative representation among all palm species in a local area ranges from 0.5% up to 54.5% (Kahn and de Granville 1992). In the Llanos of the Orinoco Basin, *M. flexuosa* densities of 20 individuals/ha are reported for *morichals*. These swampy areas in which the water can seasonally reach depths of 40 cm constitute well-defined vegetational units with a species composition distinct from that of the surrounding savanna (Blydenstein 1967, Beard 1944, Ramirez and Brito 1990). No density information is available for *M. flexuosa* in gallery forests of the Llanos, but in some areas it seems to occur in greater numbers than those indicated for seasonal swamps.

CUMULATIVE EXPLOITATION EFFECTS

The most important use of *M. flexuosa* among the ***čiri kʰonome*** Pumé is for thatching houses and other shelters; this is also the observation made of their neighbors to the south, the Guahibo, and several Indian groups of the Guiana region (Balick 1979, Lévi-Strauss 1950). The second most significant use of *M. flexuosa* among the Pumé is to obtain fiber. As practiced by the Pumé, both extracting fronds for thatch and the sword leaf for fiber destroy a palm and thus these two activities can have a significant impact on the local standing population of *M. flexuosa*. The ***čiri kʰonome*** Pumé of any given community are attentive to the population size of mature *M. flexuosa* within "their" portion of savanna. In locating settlements, the Pumé speak of the importance of being within easy walking distance of a palm swamp since all fronds extracted for thatch are carried on their backs from source to destination (Figure 2).

Other uses of *M. flexuosa* among the Pumé are either secondary or incidental to thatching and fiber. For example, a palm will seldom be cut for the sole purpose of extracting the heart; however, if the sword leaf is taken for fiber or leaves are col-

FIG. 2.—Pumé man returning to community with *M. flexuosa* fronds to be used in house thatching.

lected for thatch then the heart is usually taken as well. *Rhynchophorus* larvae are collected from the rotten stems of *M. flexuosa* cut in previous years to obtain thatch; however, I have no indication the Pumé actively create habitats for *Rhynchophorus* by cutting palms for that purpose alone. There are no good natural substitutes in the interfluvial zones occupied by ***čiri kʰonome*** Pumé for the thatch and fiber produced from *M. flexuosa*. The ***bea kʰonome*** Pumé living along major rivers in the region such as the Capanaparo, Cinaruco and Riecito use *M. flexuosa* for thatching, but *Astrocaryum jauari* (Palmae) is commonly substituted for fiber. While commercial substitutes for thatch and fiber can be obtained this depends on the availability of cash, which is still a rare commodity among the Pumé (both ***čiri kʰonome*** and ***bea kʰonome***) in this area of Venezuela. Zinc roofing sheets, for example, are expensive for the Pumé (each sheet is equivalent to about two weeks fulltime labor), difficult to transport and ultimately less comfortable to live under than palm thatch in this environment.

While the local population of *M. flexuosa* may be considered by the Pumé in their settlement decisions, a more significant concern to the long-term viability of a given Pumé community are the cumulative effects harvesting this palm has on the local environment. Some idea of the significance of these effects to Pumé community viability can be gained by considering in more detail house thatching. The ***čiri kʰonome*** Pumé construct three types of palm-thatched shelters: 1) multifamily houses used in wet-season settlements; 2) nuclear-family houses used in dry-season settlements and wet-season camps; and 3) conical huts used in early and late dry-season camps. A ***čiri kʰonome*** Pumé community will normally use in the

TABLE 3.—Use of *Mauritia flexuosa* for thatch by Pumé of the community of Doro Ana.

Site	House type	Season occupied	Total fronds/ village	Number of houses/village	Average fronds/house
S-1	multi	wet	6,208	5	1,242
s-2	nuclear	dry	4,956	12	451
c-1	nuclear	wet	2,334	6	398

course of a year one wet-season settlement, one dry-season settlement, and a variable number of camps that may be as many as 10 (not all of which have palm-thatched shelters). Conical huts will not be considered further as they are temporary shelters used for a few days to a few weeks and the thatch used is generally recycled into multifamily and nuclear family houses.

Multifamily and nuclear-family houses are lived-in for up to six months out of a year and the annual reoccupation of houses is ensured by periodic replacement of thatch and other structural components as they deteriorate. *M. flexuosa* fronds used as thatch are reported to have a 2- to 3-year lifespan by the Pumé and others (Balick 1984; Peters, personal communication 1987); from personal experience, fronds in the Llanos become brittle to the touch and somewhat bug-eaten in as little as 12 months although their condition remains good enough to last one more year. The ***čiri k^{h}onome*** Pumé reoccupy a given settlement for three to five years; after this amount of time, the thatch on houses is infested with insects such as centipedes and scorpions, and the wooden frame is riddled with termites and is structurally unsound. Replacing individual building components seldom solves these problems and houses at this point must be completely rebuilt. Frequently, the entire village is simply relocated since another major consideration noted by the Pumé in a village this age (particularly dry-season villages) is dust—continuous trampling pulverizes surface materials which are then more readily airborne during the dry season when average daytime wind speed is 4.2 km/hr (calculated from raw data provided by MARNR[2]).

A substantial number of palms must be cut to provide thatch for Pumé houses on a 2- to 3-year interval. Based on information collected in the ***čiri k^{h}onome*** Pumé community of Doro Ana during 1986–87, the average multifamily house contains 1,242 fronds and a nuclear-family house contains between 389 and 451 fronds (Table 3). (The average conical hut contains 15 fronds.) Given the average production of 11.7 thatching-fronds/palm (Table 4) and using a frond lifespan of 2 years translates into an annualized requirement of approximately 53 palms to provide enough thatch for the average multifamily house and between 16.6 and 19.3 palms for a nuclear family house. There is a total of 13,498 fronds in the various houses maintained by the ***čiri k^{h}onome*** Pumé community of Doro Ana, which translates into an annualized requirement of 576.8 palms. How this cropping rate ties into local turnover rates (mortality + recruitment) of *M. flexuosa* is unknown; however, another dimension of this cropping rate that can be estimated is the circulation of biomass within the local environment.

TABLE 4.—Leaf yield per palm of *Mauritia flexuosa* harvested for thatch by Pumé of the community of Doro Ana.

Frond Quality	n	% Total	Average fronds/palm[1,2]
mature	240	75.9	10.9 (sd 2.5)
senescent	18	5.7	0.8 (sd 1.8)
lost in felling	58	18.4	2.6 (sd 2.8)
Total	316	100.0	14.4

[1]Based on n = 22 palms.
[2]Thatching-fronds = mature + senescent or 11.7 (sd 3.3) fronds/palm.

The total of 13,498 fronds used in thatching by the community of Doro Ana translates into an annualized demand of 6,749 fronds exported from a palm swamp; these fronds will eventually be disposed in village dumps as they deteriorate and represent an estimated contribution to the soil of the three settlements involved of 3,373 kg of dry matter. [3] It is not possible to estimate with any accuracy the dry-weight contribution the stems and root mass of 576.8 mature palms would have on the palm swamp environment in which they were cut; I did not collect weights for stems or roots and no biomass measures currently exist for the woody portions of M. *flexuosa*. However, if *Elaeis guineensis* (Palmae, the African oil-palm) which has growth habits similar to M. *flexuosa* can be used as a reasonable starting analog, the stems alone of 576.8 palms would contribute somewhere on the order of 147,661 kg of dry matter.[4]

CONCLUSION

The issue of how low-intensity human disturbance can accumulate over time resulting in noticeable changes in natural environments is an important question in tropical ecosystems. During the Holocene history of Lowland South America, for example, the disposal of organic refuse by humans over long periods of time led to the genesis of terra preta soils throughout many parts of Amazonia (Eden *et al.* 1984, Balée 1988, Clark and Uhl 1987). Low-intensity disturbance has important implications for the future as well as revised tenure systems are implemented in frontier settings and these systems lead to changes in rates of resource exploitation (Bodley and Benson 1979, Stearman and Redford 1992, May 1986).

NOTES

[1] Voucher specimens for plants reported in this article are deposited in the Dr. Victor Manuel Ovalles Herbarium (MYF) and duplicates will eventually be placed at the Venezuelan National Herbarium (VEN) and the Missouri Botanical Garden (MO).

[2] Ministerio del Ambiente y de los Recursos Naturales Renovables, República de Venezuela

[3] The average weight of fronds used by the Pumé of Doro Ana for thatching is 833 g (n = 180

fronds). The average dry-weight contribution of fronds is calculated by taking 60% of the total estimated weight.

[4] The average dry-weight content of *Elaeis guineensis* (Palmae) stems is 256 kg (n = 6 mature individuals of different ages) (Hartley 1977).

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